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CRITIQUE OF THE BROADWATER-MISSOURI IRRIGATION PROJECT

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

IN COOPERATION WITH THE
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CRITIQUE OF THE

BROADWATER-MISSOURI IRRIGATION PROJECT

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CHAPTER I - PURPOSE AND SCOPE

The Water Resources Division of the Montana Department of Natural Resources and Conservation (formerly the Montana Water Resources Board) has been or is directly or indirectly associated with planning, construction or maintenance of 773 irrigation projects in the State of Montana. Presently, about 90 of these are under the supervision of this Division. Thirty-three of these are classified as major projects.

In general, most of these projects were constructed by the Water Resources Board with federal and state grants and loans. The loans are recoverable from the water users' associations. The associations are responsible for operation and maintenance of the projects. In case of serious maintenance problems, they consult the Board to get technical and financial assistance. Thus, there is a peculiar situation in that the Board, which owns most of the projects, does not directly get involved with the day to day maintenance of the projects, but at the same time is expected to keep a continuous interest. Moreover, recent failures of some dams and resulting devastation elsewhere in the country underscores the need for close watch on vital structures.

In this situation the question arises as to how much of management should the Board do, without interference with the relative autonomy enjoyed by the water users. The intention obviously is not to increase bureaucracy but to exercise the required amount of control. While dams are important and their inspection is a must, there are many other structures in a canal system which deserve attention, fairly in advance of actual failure. The water users' associations normally hire a ditch-rider who opens the turnouts and attends to the obvious leaks, etc. Usually he will not have the technical know how to anticipate trouble and plan remedial action. At the same time, should the Board, possessing the engineering know how, constantly attend to the hundreds of structures in the canal systems in all these numerous projects? It is obviously impractical and unnecessary. A compromise is the "critique" approach to the management of small projects.

The Legislative Audit

In 1971, the legislative auditor conducted an audit of the Board for the financial year ending June 30, 1970. His report contained some important observations and recommendations. Some excerpts are given below:

> *Observations*
>
> *The statutes authorizing the Board to construct water projects generally provide that the projects be self-sustaining to the extent that revenues derived from each project should be sufficient to pay the costs of maintaining, repairing, and operating the project, in addition to providing monies for debt retirement. In fact, Section 89--105R.C.M. 1947, specified that the self-sustaining capability of each respective project must be estimated before constructing the project and that unless such capability is demonstrated, the project cannot be constructed.*

Analysis of the projects constructed by the Board disclosed that not all the projects have been self-sustaining and that, as a result, the state, in all probability, will not recover upwards to $3,000,000 of the state investment in construction costs that should be recoverable.

It is fairly obvious, in our opinion, that the revenues generated by the projects have not been sufficient to recover the costs in accordance with law. We believe this condition has resulted primarily from: (1) the method used by the Board to originally estimate the financial feasibility of the projects; (2) the failure to insure that all users of the projects are paying the appropriate amounts for benefits received.

The statutory requirement that water projects be self-sustaining not only encompasses the cost of construction as previously discussed, but also pertains to the expenses of operation, maintenance, and repair of the projects.

Not only is the state paying expenses on these projects which are supposed to be self-sufficient, but our visits to selected project sites disclosed that many of the projects are in serious conditions of disrepair. In some cases the repairs needed are major and the water users' associations do not have the money necessary to accomplish the work. For example, one canal at the Flint Creek project is leaking to the extent that water from the canal is flooding private property. The leakage has apparently been serious enough to result in the water user association being served with papers pertaining to a potential damage suit which, we have been advised, has been settled without court action. In a similar situation at the Nevada Creek project water is seeping from a project canal at a rate which is reportedly damaging a farmer's property. Because of this, the farmer has threatened to obtain an injunction to prohibit the use of the canal until the problem is rectified. An association official estimated that it would cost about $100,000 or more to remedy the situation and that since only four people are using the water from the canal, such an expense would be impossible to recover. The dam at the project is also in seemingly dangerous condition in that the concrete spillway is cracked and breaking away, the control gate is leaking, and the earth fill dam has large trees growing in it.

Another project, the West Fork of the Bitterroot, has defects in the dam which, although may be not dangerous at the present time, could become crucial in the future. For example, the concrete on the spillway is cracking and crumbling to the extent that a six-inch hole exists in the side of the spillway. As a result of this hole and other cracks in the concrete, water leaks around the spillway and down the face of the earth fill dam. Similar conditions of disrepair were observed at almost all of the projects which we visited.

Recommendations

The final alternative available to the Board, which we believe is most feasible and acceptable, is for the Board to assume control of the projects to the extent that necessary maintenance and repair are accomplished and properly financed. To this end, we believe the Board should formulate a written critique for each project on the basis of consultation with water users and analysis of Board records. This critique should, in our opinion, include:

1. A factual determination of the past, present, and future direct and indirect benefits from each project.
2. A determination and evaluation of the reasons why revenue from operation and maintenance charges has been insufficient to support the full extent of operation, maintenance, and repair expenses.
3. An accounting of state expenditures on the project for operation, maintenance and repair, and the status of those expenditures insofar as repayment is concerned.
4. A determination of what additional maintenance and repair work is warranted for each project in terms of potential direct and indirect benefits to the water users and the state.
5. A determination of the various alternatives available to the Board in recovering, writing off, or otherwise disposing of past state expenditures for operation and maintenance.
6. A determination of the most appropriate manner of accomplishing and financing operation, maintenance, and repair in the future for each project.

Once the foregoing critique has been formulated for each project under the Board's jurisdiction, we believe the Board should resolve the status of each project by abandoning those projects which are providing no benefits and have no real potential, and restoring and maintaing those projects which are beneficial or which have unrealized benefits. With respect to those beneficial projects, the Board should take whatever action appropriate to finance and effectuate the restoration of the projects. In accomplishing this, the Board should, in our opinion, set the level of charges to water users for operation and maintenance at a level which will provide sufficient revenue to (1) reimburse the state for past expenditures determined to be recoverable, (2) accumulate a reserve for contingencies. These considerations are necessary since each project is required by law to be self-sustaining insofar as operation and maintenance are concerned.

Part of the objective of this WICHE project is to develop a format and evolve methods of study for the "critique" referred above. In this direction, first of all, it was noted that the legislative audit pertains to two aspects:

1. Financial and administrative
2. Technical

This "critique" is mainly addressed to the technical aspect, with limited observations on the financial and administrative aspects.

Due to limitations of time, only one project - Broadwater-Missouri Irrigation Project - is studied. However, the methodology and format developed here are applicable to other projects and, hence, it is expected that "critiques" of other projects can be accomplished in due course.

Procedure

The procedure followed in this study is as follows:

1. Discussions with the water users' association to find their needs and locate problem areas.
2. Inspection of the entire project and assessment of the condition of the various structures.
3. Consideration of alternatives and decisions regarding repair or replacement of the old structure.
4. Study of the problem areas located as a result of discussion with the water users and the ditchrider.
5. Inspection of the problem areas.
6. Office studies of alternative solutions to the problems.
7. Discuss the alternatives with the water users and select the alternative best suited to the field conditions.
8. Consider the general O&M practices and suggest improvements if necessary.
9. Locate possible future uses of the project waters and consequent changes needed in the overall system.
10. Study the financial situation of the project and possible methods of increasing the revenues or earlier debt retirement.
11. Summarize the study and recommendations.

CHAPTER II - MONTANA WATER RESOURCES BOARD: HISTORY AND POLICIES

The severe drought conditions of the 1930's had a serious effect on agriculture and livestock industries of Montana. This drought combined with the depression of the early 30's, created a gloomy outlook and serious unemployment. To combat these conditions, in 1933, the federal government established work programs designed to encourage construction of public works and alleviate unemployment. The state and the federal governments were quite unprepared for such an emergency and hence there was no well thought out plan for the so called Public Works. Anything that resulted in some employment and permitted legitimate payment of wages, instead of giving away money to the otherwise unemployed people was considered as fit for consideration under this program. Since Montana was heavily dependent on agriculture and livestock industries, the need for construction of water conservation projects was seriously felt. In this direction, Governor Cooney suggested to President Roosevelt that Montana be allowed to proceed with such a program under the loan and grant offers being made by the Federal Public Works Administration. The President agreed to this proposal and offered that Montana could expect financial assistance up to $5,000,000 from the P.W.A. if they would enact a suitable legislation under which the government could buy the bonds of the state agency. This was followed up promptly, and the Montana legislature, at a special session late in 1933, passed House Bill No. 39, creating the Montana Water Conservation Board. The Board met for the first time on January 22, 1934.

The act creating the Board declared that public interest, welfare, convenience and necessity required construction of a system of works for conservation, development, storage, distribution, and utilization of water. Water conservation was declared as a state purpose and the Board was declared to be performing governmental functions in carrying out its duties. The act specified the Board as a body corporate and politic with perpetual existance as an agency of the State of Montana. The Board was given powers to cooperate and enter into agreements with all federal and state agencies, and to investigate, survey, construct, operate and maintain, and finance the construction of projects either through funds appropriated to it, by grants, or by the sale of water conservation revenue bonds. The Board was given authority to issue and service the bonds. The Board was given authority to file on all unappropriated waters of the state and the right of eminent domain to assure land needed for construction of projects. As far as possible the Board applied the following criteria in selection of projects:

1. Engineering feasibility, i.e., availability of a certain quantity of water at a certain cost.
2. There was land available for applying this water profitably to increase overall production such that the cost of the project and its operation and maintenance costs could be recovered.
3. There were water users who could make profitable use of water.

The board also recognized the need for long-term planning to meet the ultimate demands of the area.

In the early years of its formation, the board had to act more out of necessity than judgement. There were several restrictions on the federal funds provided and the choice was either to meet the deadlines and restrictions or lose the grant. With a lack of trained engineers for dam and canal construction, etc., the problems were more complex. The drought-stricken farmers were very conscious of the need for irrigation and brought pressure on the board for construction of projects. Political pressures played an important role in winning federal funding resulting in projects being approved, not necessarily on the basis of engineering efficiency. Once federal funding was approved for a certain project, often based on minimum scrutiny due to lack of time, there were deadlines to be met for various phases of progress. Though several projects were constructed during the period of federal assistance, they were not necessarily the best possible from the point of view of overall efficiency. Other limitations which retarded full growth included acreage restrictions on farm production, restrictions on construction of projects for primary supply, etc.

Overall, the state has done its best to take advantage of federal help in constructing irrigation projects so essential for the economic growth of an agricultural state like Montana. Even though several other western states passed similar water conservation legislation, only Montana was successful in securing federal funding for a construction program. Credit for this goes to the Governors and board members for their willingness to compromise and meet the requirements of federal agencies administering the funds. The legislature also lent support and understanding in appropriating the state's part of the funds needed.

In 1950, funds were discontinued by Congress for these projects and the tempo of construction retarded. In 1951, federal government sold back to the state all outstanding bonds at a concessional rate. Bonds worth $3,926,835 were bought at $1,534,882. This enabled the state to reduce repayments due from water users on many projects constructed with federal assistance.

In 1967, the State Water Conservation Board was renamed as the Montana Water Resources Board and in 1971 under the re-organization program, it became the Water Resources Division of the Department of Natural Resources and Conservation. In the course of these changes, the powers and responsibilities of the board expanded, but the basic interest of the board in developing Montana's water resources remains. At present, the board is engaged in preparing a water plan for Montana, and to preserve for Montana a prior right to use water for its projects as against claims which might subsequently be made by downstream states.

CHAPTER III BROADWATER COUNTY

History

Broadwater County was established in 1897 from parts of Meagher and Jefferson Counties. There are two versions as to why it is named Broadwater County: one school holds that it is named so after Col. C. A. Broadwater, a prominent resident of the area. Another school says that it is so named due to the broad Missouri River flowing through the County. Whatever might be the correct version, the later version seems well justified considering the abundance of water in the County. This area was part of the Blackfeet and Crow hunting ground before the arrival of the white man. The first recorded visit of white men is that of the Lewis and Clark expedition in 1805-1806. Later there was some traffic of trappers and fur traders up the Missouri River. The first real settlements in the area took place during the gold rush days. The first gold discovery was in Confederate Gulch in 1864. Soon the entire area was flooded with prospectors and miners and Diamond City became the center of all this activity. Then the Pacific Railroad was extended to the area, and Centerville, presently Townsend, became the center of railroad activity. In fact, Townsend is named after a prominent railroad official. When Broadwater County came into being the main "metropolis" of the area, Townsend, became its logical seat. As the gold mines became empty, Diamond City was deserted and people discovered the real liquid gold, water, and started irrigation and agriculture. How wise they are to rely on liquid gold, something more permanent and inexhaustible than the glittering temporary gold in the mines! Ever since, agriculture has been the main business of the County.

Transportation

The main Highway U. S. 287 passes through the middle of the County and connects Townsend, Toston and Winston with Helena and Three Forks. At Three Forks, U. S. 287 joins Interstate 90, one of the main arteries of the National Highway System. The other main Highway, U. S. 12, takes off from U. S. 287 at Townsend and connects with White Sulphur Springs to the east. U. S. 286 takes off U. S. 12 a few miles east of Townsend and goes north and northwest following the Canyon Ferry Lake. Another paved road connects Toston to Radersburg in the west. A graded road continues beyond to the Boulder Valley road in Jefferson County. There are other smaller roads and dirt roads connecting farms and ranches.

Two railroads, Northern Pacific Railway and the Milwaukee Railroad serve the County. The Northern Pacific Railway enters the County at Lombard and follows the Missouri River to Toston, then it follows almost parallel to U. S. Highway 287 North up to Louisville, where both leave the County. The Milwaukee Railroad enters the County east of Lombard when it crosses Sixteen Mile Creek. Near Lombard it crosses the Missouri River and follows south on the west bank of the river to a point near the mouth of the Madison River where it leaves the County. Even though passenger traffic ceased on these railroads, they serve as very vital freight carriers for exporting grains out of state. Some freight-carrying trucklines also serve the area. Greyhound and Intermountain Bus Lines serve the passenger traffic to the area. The nearest airport is at Helena, a distance of 36 miles from Townsend. A small air strip exists at Townsend for small private aircraft.

Soils

About 45% of Broadwater County is included in the Belt and Elkhorn Mountains. The Missouri River forms its southern boundary and then flows north through the county. The stream valley mostly consists of alluvial deposits and the remainder of the valley consists of outwash materials of Tertiary age. The bedrock material in the mountains and adjacent foothills consists of granite, limestones, quartzites, and argillites. Soils in the valley, particularly under the Broadwater-Missouri Project area, belong to two soil associations viz. (1) bottomland and low terraces and (2) intermediate terraces and fans.

Bottom lands and terraces mainly consist of soil groups Valley-Toston and Riviera. The valley soils and other wetland soils are on nearly level terraces, usually separated from the main streams by the Riviera Soils. They are deep loam and silty clay loam soils that are poorly to very poorly drained. They have a high water table that is at or near the surface during most of the year. The Toston soils are also on the first and second terraces above the stream. They are loamy saline-alkali soils with a seasonal water table above 40 inches. Riviera soils are sandy, gravelly soils on the first terraces above the stream and within the flood plain of the stream. They also have a seasonal water table above 40 inches and are subject to annual or more frequent overflow. This association of soils is primarily used for pasture and hayland. Some of the soils with seasonal water tables are drainable, others near the streams are not. The second association of soils in this region consists mostly of Amesha soils. Amesha soils are deep, well-drained, strongly calcaceous, loamy soils. They are of the better irrigable and dry cropland soils. Included in this association are Havre soils, less calcaceous than Amesha soils and Musselshell soils which are more gravelly than Amesha soils. There are some Crago soils also, which are more gravelly than Amesha soils at shallower depths. The soils in this association are very suitable to irrigation and in fact the majority of the irrigated area in the project consists of this kind of soils.

Climate

The climate of the Townsend area may be described as modified continental with several factors entering into the modification of continental climate characteristics. The more important of these factors are the frequent invasions of Pacific Ocean air masses, drainage of cool air into the valley from the surrounding mountains, and the protecting mountain shield in all directions which makes temperature changes somewhat smaller than those expected of a true continental climate. Terrain also is an important factor in the area's precipitation patterns as the surrounding mountains cause a "rain shadow" effect in the valley of the Missouri River. Annual precipitation varries from less than 12 inches in the valley floor to about 40 inches in the higher elevations both east and west of the valley. About three-fourths of the usual year's precipitation falls during the six months of April through September with May and June normally being the wettest months.

During the cold season nearly all precipitation falls as snow. At the lower elevations snow usually does not remain on the ground for extended periods of time, but in the mountains snow begins accumulating in November most years, reaching the greatest depths and water contents in April or early May.

Infrequently, heavy rains in late May or June coincide with periods of maximum melting of the mountain snowpack, and this combination will cause some degree of flooding in some streams. However, flooding is not a serious problem in the area.

Rain of a steady character may occur in any year April - June, but summer precipitation almost always is showery. Winter snows tend to be heaviest in December and January, but water content of the snow is usually low. Snowfall in the higher mountains is estimated to reach totals of about 200 inches annually with the yearly snowfall decreasing to approximately 30 inches in the valley floor.

During winter seasons there usually are a few invasions of very cold Arctic air with temperatures dropping to well below zero. The extreme cold usually lasts only a few days, but extended cold spells do occur occasionally. Snow and blowing snow sometimes accompany the cold-air invasions, but this type of storm usually lasts only a day or two. Mild periods of weather are common during the winter with above-freezing temperatures in the valley floor. However, these mild conditions are not as common in the Townsend area as they are to the east along the East Slopes of the Rocky Mountains.

Summertime temperatures are moderate, with maximum readings generally under 90° and very seldom reaching 100°. There is usually a marked change in temperature from day to night and this tends to produce an agreeable combination of fairly warm days and cool nights during the summer. The growing season averages 103 days at Townsend, but in the higher elevations the season is shorter.

Thunderstorms are rather frequent from May through August with the maximum occurrence in July. However, damaging hailstorms, as well as severe ice or sleet storms in wintertime, are seldom observed. Strong winds can occur at any time throughout the year, but generally don't last more than a few hours at a time.

Income and Level of Living

The Broadwater County was originally settled by miners and prospectors. As most of the mines became exhausted and were abondoned, old mining communities turned into ghost towns and the emphasis shifted to agriculture and the raising of livestock. With abundant water supply available from the Missouri River and the various tributary creeks, and with fertile soils, agriculture in this area is quite a successful operation. According to "Montana Agricultural Statistics", published by Montana Department of Agriculture, in 1969, total cash receipts from the sale of livestock and crops was $6,372,300. Of this, the sale of livestock and livestock products accounts for $4,630,800.

Level of Living

Farm operator level of living indexes are designed to measure the relative well being of farm operator families. The U. S. Department of Agriculture prepares and publishes these indexes occasionally. The following table is completed from U. S. Department of Agriculture Publications, statistical Bulletin Nos.204 (1957), 321 (1962), and 406 (1967).

TABLE: Level of Living Indexes

	1930	1940	1945	1950	1954	1959	1964
Broadwater County	46.3	50.8	59	85	86.5	140	149
Montana	36.7	40.2	51.6	71	72	126	144
United States	36.2	38.2	48.9	59	67.6	100	122

NOTE: 1. All values have been adjusted to the base U. S. County average in 1959=100.
2. 1950 onwards, Broadwater County averages reflect averages for Broadwater, Meagher and Park Counties.

From this table it may be seen that the farmers in this area enjoy a generally higher level of living as compared to the national and state average. The rapid increase in the level of living in Broadwater County after 1940, when the Broadwater-Missouri Diversion project started operation, may be noted.

A recent survey showed that the average age of farmers in the Broadwater County is about 51 years. However, the number of young farmers is on the increase.

Housing and Other Amenities

The farmers normally live on the farm itself. Some of the farmers however, choose to live in Toston, Townsend or Radersburg. Those living in these towns, particularly in Townsend, have to share the municipal responsibilites with those who use this town as a "bedroom" while working in Helena for a living. Occassionally this diversity has created some problems, but none too serious. The population of the county is so small (approximately 2,500 or 2 per sq.mi.), that they have to depend on Helena, 35 miles away for some facilities like scheduled airlines, a college, T. V., radio stations, etc. Basic amenities like stores, restaraunts, gas stations, etc., are available in the county itself.

Rural Financing

Agriculture is no longer an attractive area for short-term loans from commercial banks. Insurance companies also have curtailed their loans on farms and ranches.

However, there is a great demand for credit for capital investment and operating expenses. Farmers Home Administration, Production Credit Association, and some commercial banks are presently handling these credit demands.

Land-Use and Livestock Practices

Agriculture is the main business in the area. The following distribution of crops gives an idea of cropping preferences in this county. (Source; Broadwater County Situation Statement 1972, by U. S. D. A. Committee for Rural Development)

	Dry Cropland	Irrigated	Total	%
Wild Hay	700	10,100	10,800	9.8
Alfalfa	1,100	19,900	21,000	19.1
Potatoes		500	500	.5
Beets		2,020	2,020	1.8
Barley	10,096	4,180	14,276	13.0
Oats	590	600	1,190	1.1
Corn	300	500	800	.7
Wheat	21,364	2,200	23,564	21.4
Summer Fallow	35,850		35,850	32.6
Total Cropland	70,000	40,000	110,000	100.0

Wheat is normally produced on dry land farms and most of the irrigated land is used for livestock feed. This is not surprising since the main business in this area is livestock. In 1970 there were 36,000 head of livestock in the county. Most of the beef cattle enterprise in this county consists of commercial cow-calf operations. Most of the livestock feed produced is preserved for winter feed. In summer time the grazing lands in the national forest are used. For this purpose grazing associations of farmers are organized. Cross breeding is quite popular. Artificial insemination is not very common. Some of the ranchers are members of the Montana Beef Performance Association.

Marketing of cattle is primarily through contract buying. Some calves go through livestock auction markets in Butte, Bozeman, and Billings, but direct selling is prevalent.

Apart from beef cattle, some farmers practice hog production as a supplement to the already existing ranch operations. Sometimes they accept feeder pigs from other areas for fattening. Market outlets for hogs are through Butte and Bozeman livestock auctions. Hog business is on the increase and has promise for future growth. There is a limited amount of sheep and poultry enterprise also.

Food Crops

Wheat is mostly grown on dry lands. Sugar beets, potatoes and oats are also raised in this area. However, since the closure of the sugar factory in Hardin, some difficulty is being experienced in marketing sugar beets.

There is considerable timber and lumbering activity in the forested areas.

Wilderness and Recreation Areas

There are no wilderness areas within Broadwater county. However, there are approximately 10,000 acres of roadless area. Much of this area retains its primeval character due to its location and characteristics of the land. Within a few hours reach there are other forest areas like Helena National Forest, Gallatin National Forest, etc., which offer excellent opportunities for back packing, hiking, etc. Yellowstone and Glacier National Parks are also within a days reach. The nearest recreation area is the Canyon Ferry dam and reservoir, where there are excellent facilities for boating, fishing and other water based recreation.

CHAPTER IV

BROADWATER-MISSOURI DIVERSION PROJECT - ASSESSMENT OF PRESENT STRUCTURES

General

The project begins with a concrete diversion dam across the Missouri River, located about five miles above Toston in Broadwater County. The dam is 705' long and 56' high to the top of the retaining wall(40' to spillway crest). The spillway is designed for a flood of 50,000 cfs. The main canal, designed to carry 342 cfs, is 1.5 miles long. About 3,000' of this canal was lined in 1967 and the rest of the reach is being lined under a project already approved. After this, the canal divides itself into two branches, the west canal and the east canal. The east canal is designed to carry 262 cfs and the west canal is designed for 90 cfs. Figure 1 is a map of the project.

Soon after the diversion, the east canal crosses the Missouri River in a steel pipe line 84" in diameter and 666.6 feet long, supported by concrete piers at a height of 25 feet above the bottom of the river. The canal then runs in a northerly direction for a distance of 34.3 miles crossing Six Mile Creek, Dry Creek, Greyson Creek and Deep Creek. Originally the canal was 38.6 miles long, ending at Confederate Creek. However, due to severe slides from the steep slopes traversed and resultant costly maintenance disproportionate to the limited use, the last four miles of the canal were abandoned and it now ends in Duck Creek. A further discussion on this aspect is presented elsewhere in this report.

The west side canal runs 12.4 miles crossing on the way, Warm Springs Creek and Crow Creek. One of the important structures in the west canal is the 1,445' long siphon of 48" diameter in the head reaches.

Assessment of Present Structures

All the existing structures in the canal system were surveyed and rated for their condition. An estimate is made of the life of each structure. Wherever necessary repairs or replacements are suggested. Details may be seen in Appendix I. Most structures were constructed with concrete, wood or corrugated metal pipe. The condition of the structure is rated as below:

	Poor	Fair	Good
Wooden Structure	0-2	2-5	5-10
Concrete Structure	0-5	5-15	15-20+
Metal Pipe Structure	0-5	5-15	15-20+

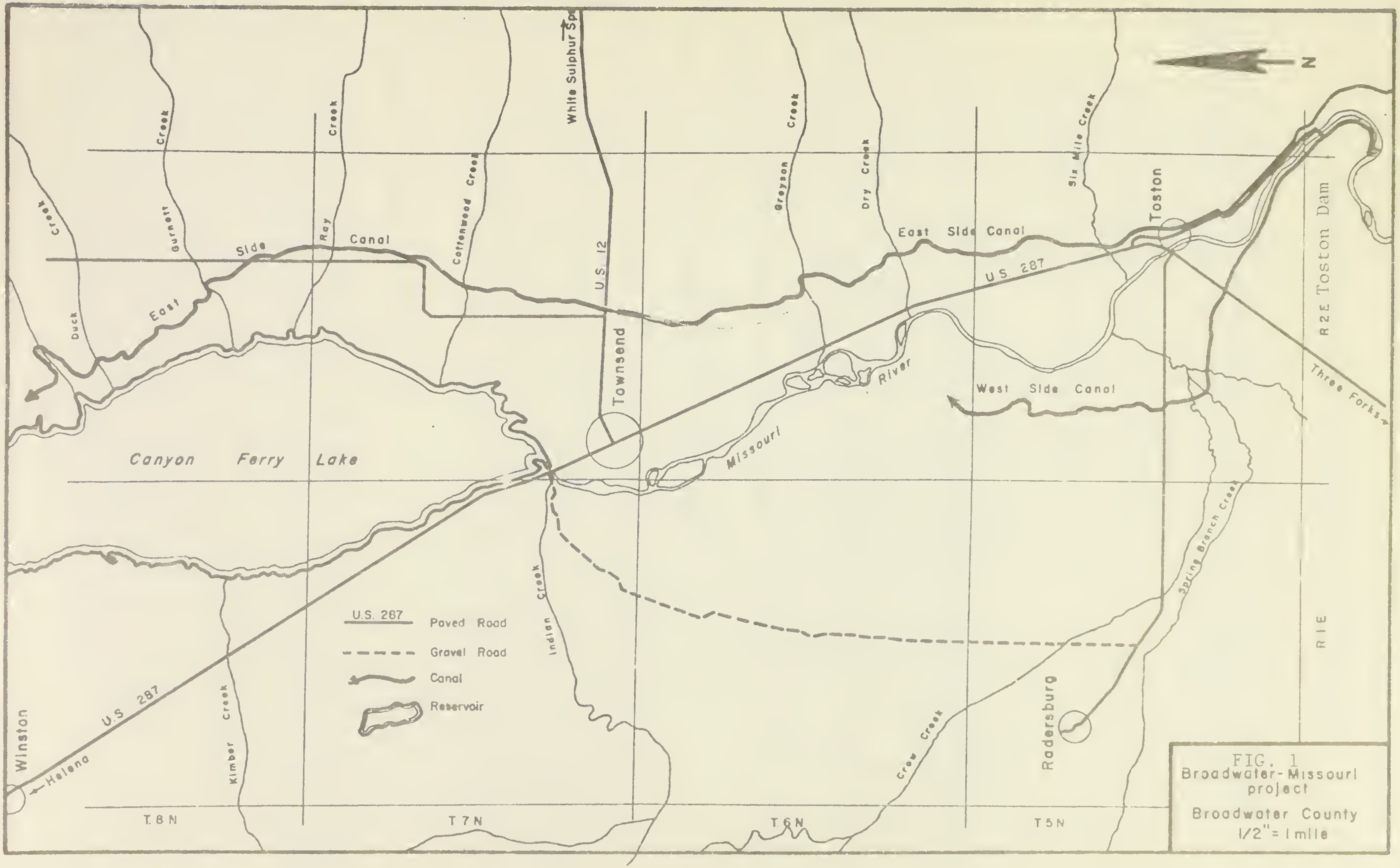


FIG. 1
Broadwater-Missouri project

Broadwater County
1/2" = 1 mile

CHAPTER V NEED FOR NEW STRUCTURES AND SUGGESTIONS

One of the first things done in the direction of suggesting improvements to the canal system was to meet with Mr. Robert Davis, President of the Broadwater-Missouri Water Users' Association. Mr.Davis listed the following problems which are currently causing concern to the water users:

1. Six Mile Creek crossing the east canal.
2. Channel improvement needed between Six Mile Creek and Dry Creek on the east canal.
3. Crow Creek crossing the west canal.
4. Reverse flow at Deep Creek spillway
5. Gates on the dam.

The next few days, the writer undertook a tour of the area with Mr. J. R. Evans, ditchrider. Some of the problems were discussed with the farmers in the area. Discussions were also held with the District Conservationist of the Soil Conservation office in Townsend. Following this fieldwork some office studies were conducted to suggest solutions for the problems. Due to limitations on time, detailed designs are not worked out for the suggestions made below. The intention is to suggest broad measures for improving the performance of the system and to suggest a routine to be followed in the study of other projects, rather than to go into detailed design on one project.

The problems mentioned above are described in greater detail and solutions are suggested below.

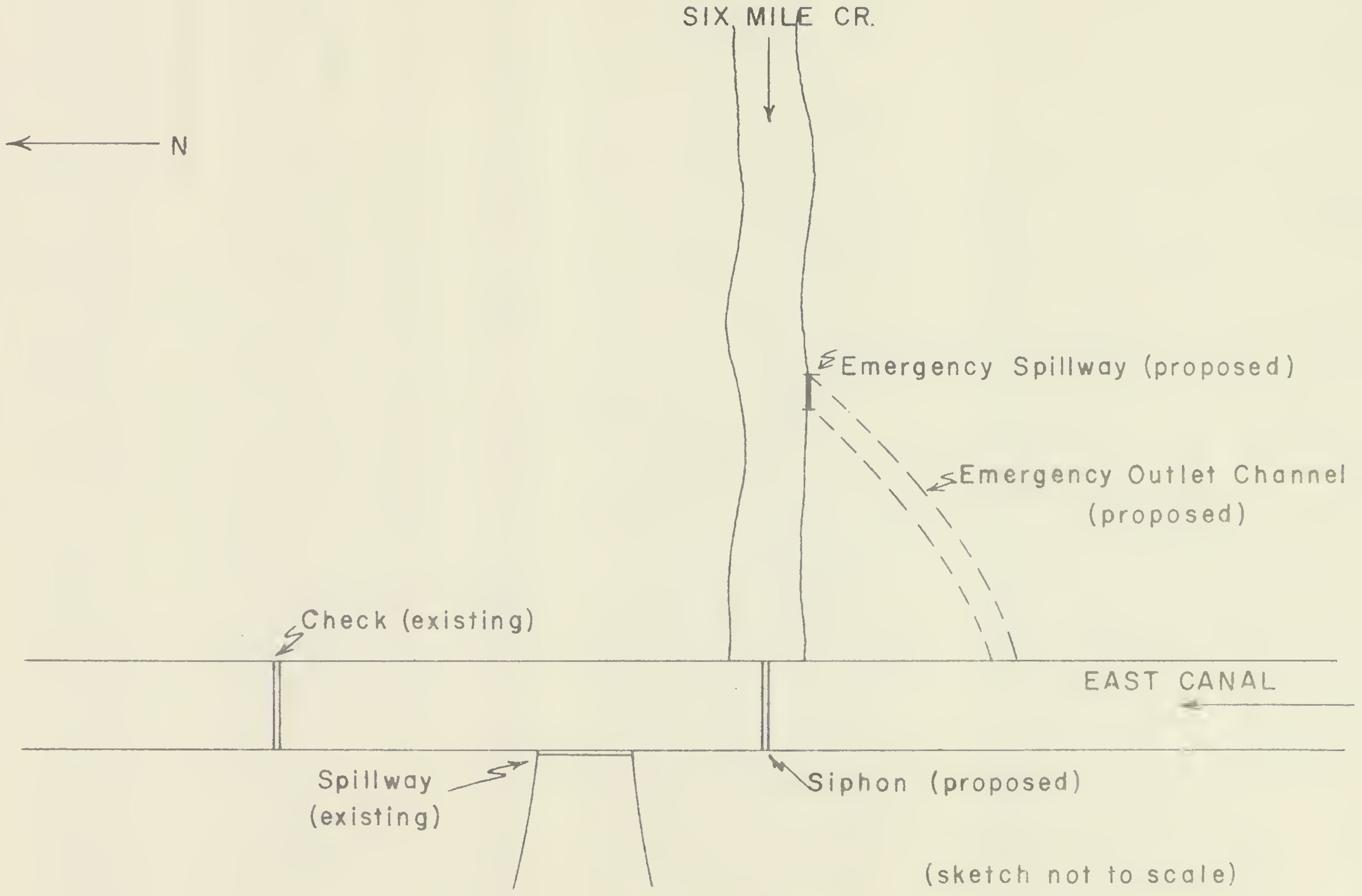
Problem #1 - Six Mile Creek Crossing the East Canal

The Problem: Six Mile Creek crosses the east canal between miles 4 and 5. At present the creek is allowed to flow into the canal and then spill out on a spillway, as shown in Figure 2. When the creek is flowing the check in the canal is closed and the creek waters are spilled out. The creek, in general, does not flow much, except for a brief period in spring when a flash flood passes down the creek. During this flash flood the creek brings in lots of sediment, sage brush and debris which gets deposited in the canal. Each year this has to be cleaned up by a dragline working an average of 10 to 20 hours. The Water Users' Association wants to avoid this situation and find a permanent solution to the problem.

Investigation and Suggested Solutions

Six Mile Creek is a small creek about 11 miles long. It originates in Six Mile Mountain and mostly courses through the mountains until about 1 ¼ miles upstream of its crossing with the canal, where it enters the plains. The course of the creek was followed upstream from the crossing to the foot hills, to observe that most of the soil in the plain area is loose soil covered with sage brush. The area seems to have never been cultivated. The channel of the creek is quite deep, indicating that sometimes there is considerable flow in the creek. There is no gage on this creek and no measurements were ever made of the flow in this creek. Efforts were made to locate the catchment of the creek on U.S.G.S. topographic maps. From a rough study it appears that the catchment of the creek is about 20 sq. miles, most of which is mountainous. The catchment is narrow with steep slopes. The maximum width of the catchment is about 4 miles, while most of the time it is less than 2 miles. From such a catchment it is not surprising

Fig. 2
SIX MILE CREEK
CROSSING EAST CANAL



(sketch not to scale)

to observe flash floods, which could occur in the spring thaw time or due to a cloudburst in the area in summer. These high flows during flash floods erode the loose soil of the banks in the plain reaches and carry all the sediments and debris. At the canal crossing all this debris and sediment gets deposited. That seems to be the problem here. The best and most practical way to solve this problem is to construct a siphon and separate the creek flow from the canal flow, so that one does not affect the other and thus reduce maintenance problems on the canal. As there is neither any gage, nor any data available on the flows in the creek, the best that can be done is to make a reasonable "Magnitude and Frequency of Floods From Drainage Areas Less Than 100 sq. Miles In Montana" by F. C. Boner and R. J. Omang of the U. S. Geological Survey, was used.

According to the procedure given in this pamphlet this area falls in region G and the corresponding 10-year flood is 200 cfs. The 25 year flood will be 200 X 1.4 = 280 cfs (page 12 of the pamphlet). However, it must be noted that this estimate is only very rough and when actual design is attempted, a more detailed analysis is recommended. This crossing is between the 4th and 5th mile on the canal. About 500 to 600 acres of area is being irrigated upstream of this crossing. The design flow in the east canal at the head is 262 cfs. However, it will be a reasonable guess that at peak condition the canal will flow at 250 cfs at this point.

A siphon on the canal or the creek for a discharge of 280 to 300 cfs is going to be a costly project. Alternatively it is suggested that a siphon may be constructed on the creek under the canal, as indicated in Figure 2. This siphon may be designed for 50 to 100 cfs flow. An emergency spillway and a diversion channel, as indicated, in broken lines in Figure 2, may also be constructed with a capacity of 150 to 200 cfs. Such an arrangement will protect the crossing using the siphon in most of the years and the emergency spillway only in extraordinary floods, which are rare in this region. A trash rack may be installed upstream from the emergency spillway to stop debris from reaching the emergency spillway and the siphon. This will prevent chokeing of the siphon.

This alternative will require about 13 yards of concrete, 100 ft. of 42" reinforced concrete pipe, a small amount of steel, 10 yards of riprap, and the necessary earth work.

Problem #2. Channel Improvement from Six Mile Creek to Dry Creek

The Problem The reach between Six Mile Creek and Dry Creek (about 4 miles) has gone out of grade. At some sections the sides have widened (up to 50%). There may be some sections where there might have been erosion on the bottom of the channel also, but it could not be seen as the channel was flowing full.

Investigation and Suggestions.

The writer investigated the problem area with Mr. J. R. Evans. The canal has widened at some places and has gone out of grade. There is no evidence of any seepage or leaks in this reach. The problem could arise due to the following causes:

1. The velocity of the canal in this reach is too high for the soils encountered in the reach. This creates excessive erosion and loss of grade.

2. Cattle grazing on the canal banks is causing collapse of side slopes particularly when the soil is loose.
3. Wind and wave action on loose soil on sides.
4. Some of the sediments and debris entering the canal from Six Mile Creek may be finding way down the channel and might be causing this instability in the channel section downstream.

Hence, it is suggested that after the siphon at Six Mile Creek crossing is constructed, in a season when the canal is dry, the channel may be regraded. The side slope and any erosion on the bottom may be fixed with shales unless actual conditions observed when the canal is empty warrant any other type of treatment.

Problem #3. Crow Creek crossing the West Canal

The problem. Crow Creek, which divides itself into several branches, crosses the west canal at two points, between miles 5 and 6. There is a spillway at each crossing. The problems being faced are:

1. Some downstream users having water rights on Crow Creek blame the canal for insufficient supplies, even if it is due to inadequate flow in the creek itself.
2. The Crow Creek divides itself into several branches in this area. Sometimes in flood season the branches overflow and form a sheet of water on the farms above the canal. Some of the farmers blame the canal for this flooding.
3. During off season, the canal downstream of the crossing sometimes remains wet and it is blamed on the perennial nature of inflow from Crow Creek.

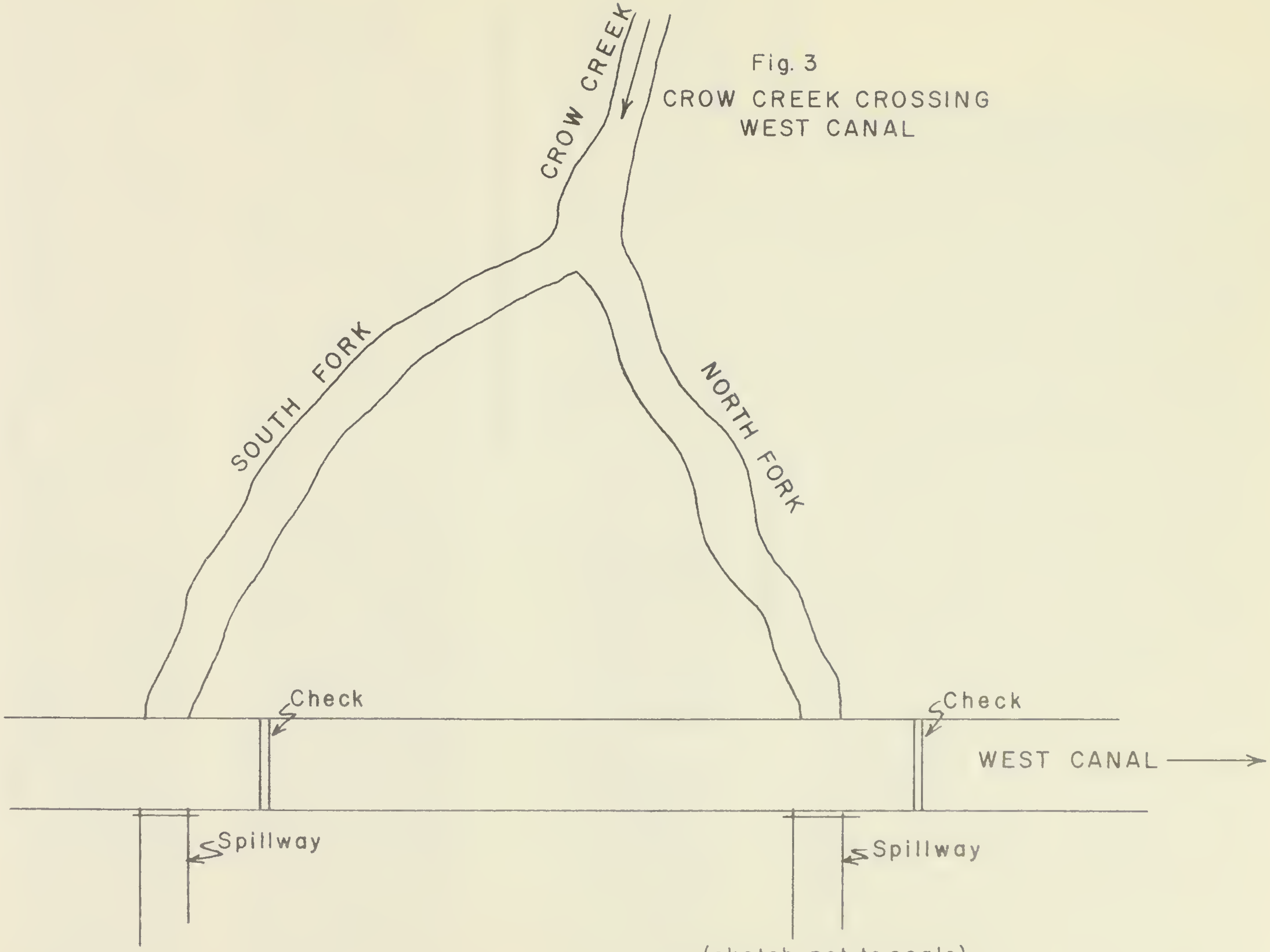
Investigation and Solution

The Crow Creek flow pattern was inspected by following its course upstream of the crossing. There is a U. S. G. S. gaging station on the creek at Radersburg. Drainage area up to this gage is 76.6 sq. miles. Data at this station is available for these periods: April to June 1901, May 1919 to September 1929, and June 1966 to date. The average flow (1919-29, 1966-70) is 48.5 cfs. The recorded maximum flow is 1,000 cfs (July 14, 1920). The normal peak is about 500 to 600 cfs. Normal minimum flow can be between 10-15 cfs. The absolute minimum ever observed was 1.4 cfs on January 10, 1922. The canal crossing is downstream of this gage site and flows of a higher magnitude can be expected. Also, if the flood is high, the various branches of the creek overflow and form a sheet of water over the entire area. In a discussion with the Water Commissioner for Crow Creek water users, Mr. Charles Huff, he mentioned that in 1969 or 1970, such a situation did occur.

The above problems can be attended to with the existing facilities as follows:

1. The spillway at the Creek crossing can be properly calibrated to measure the outflow to the downstream water users. The inflow can either be estimated from a knowledge of the flow at U.S.G.S. gage and intermediate use or can be measured at the crossing itself. It is understood that the downstream user is planning to install a parshall flume in the creek downstream of the crossing, with cost sharing from ASCS. This should solve the problem of complaints from downstream users on the quantity of flow entering the canal and leaving it.

Fig. 3
CROW CREEK CROSSING
WEST CANAL



(sketch not to scale)

2. In high floods it is likely that some of the farms above will be flooded. This would happen even without the canal being there, due to the nature of the flow of the creek in that reach. It is possible to convince the upstream owners of this natural phenomenon. It may be noted that so far there has never been a written or serious vocal complaint by any of the upstream owners. Tactful handling might avoid unpleasant situations on this score. Also, some of these owners take supplemental water from the canal and hence co-operation can be expected.
3. By manipulating the existing checks and spillway, the creek water can be stopped from flowing downstream in the canal. The wetness of the canal is due to inflow from areas above the canal. The runoff from these areas finds its way through natural depressions into the canal. This should not be a very serious problem. If maintenance work requires local dewatering, this does not appear to warrant construction of any structure, and in fact, no structure can help solve this problem, as the natural runoff is from a wide area above the canal. Any structure at Crow Creek crossing is irrelevent as the problem does not originate there.

Problem #4 Reverse Flow at Deep Creek Spillway

The problem. Deep Creek crosses the east canal between miles 12 and 13 as shown in Figure 4 the canal is siphoned under the creek. The canal receives some water from the creek at this point, which is later exchanged through a spillway in the canal. Sometimes during spring when the canal is not yet in operation and the creek gets its first floods from the spring thaw, a reverse flow from the creek to the canal over the spillway is observed. The water users wish to avoid this situation.

Investigation and Suggested Solution

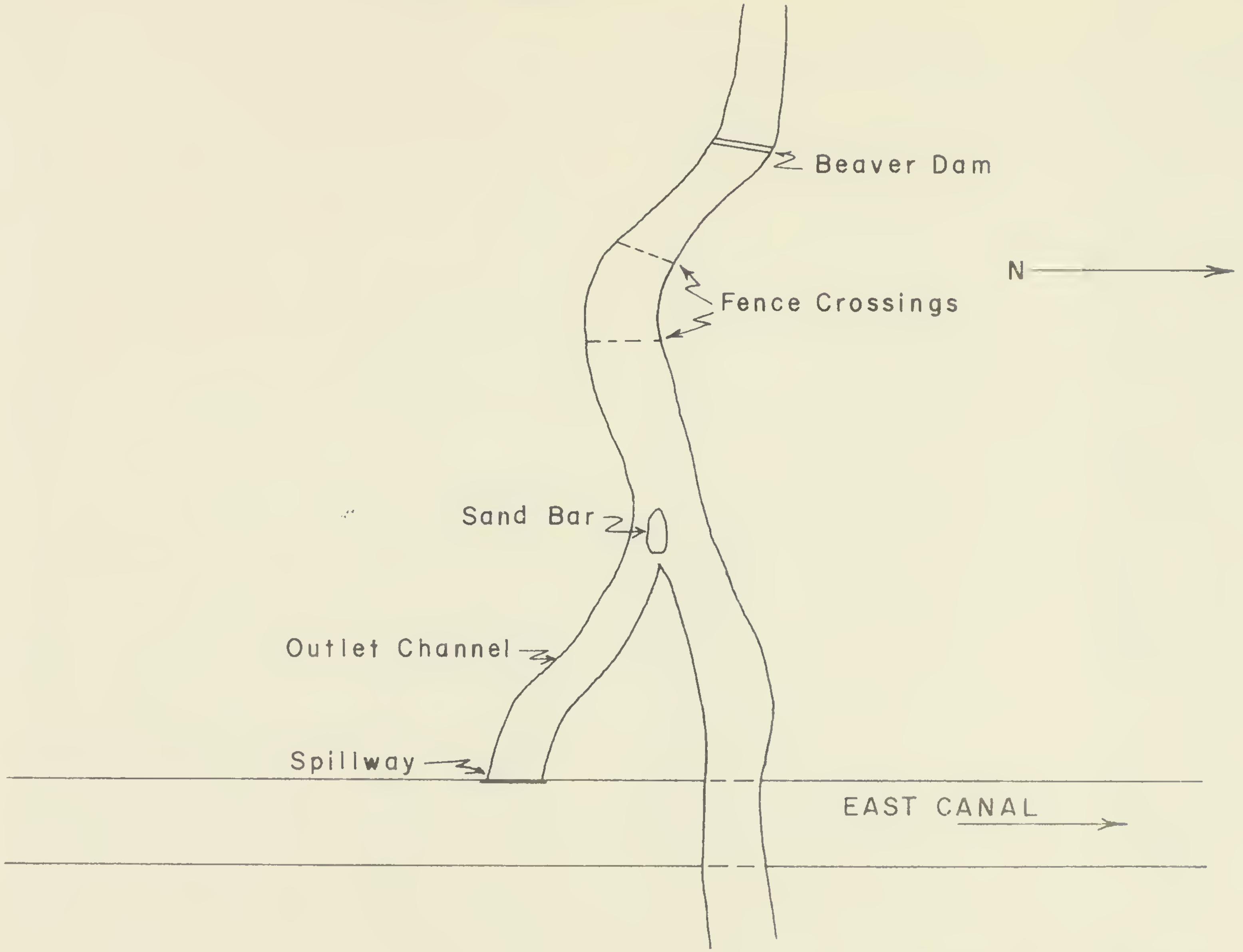
The crossing was inspected with Mr. Rick Bondy, Project Engineer and Mr. J. R. Evans, ditchrider. The creek was followed downstream of the spillway. At the junction of the approach channel and the creek there is a sandbar. Somewhat downstream at two locations, two wooden fences, presumably of neighboring farmers, were seen crossing the creek. The lower rungs of the fences were quite close to the water surface and during floods, water might be flowing over these lower rungs, resulting in these fence crossings acting as trashracks. Further downstream there is a pile of wood stacked across the creek, like a beaver dam.

There is no detailed map of the area showing levels of structures and the creek bed. However, from the inspection, it appears that the reverse flow observed is the backwater effect due to the above obstructions. These may be cleaned up before next spring. If after that some reverse flow is observed, a detailed hydraulic study of the crossing, with the help of a map showing the levels of the creek bed, siphon, spillway, etc., may have to be conducted. In any case this is a maintenance problem and no structural solution is envisaged.

Problem #5. Gates on the dam

The gates on the dam are of an antiquated design. Each bay consists of gate leaves which are dropped into place through steel guides. Erecting the guide beams is quite a tedious procedure. The one time the writer observed the operation, about 6 people worked for several hours to accomplish lifting the gates.

Fig 4
DEEP CREEK CROSSING
EAST CANAL



(sketch not to scale)

There is no trained crew to do this job on a routine basis. Whenever there is need to operate the gates, the dam tender goes to Townsend and picks up whoever is available to assist in the operation. This is not the best way to handle the diversion. It may be worthwhile to investigate the possibility of replacing these gates by a more efficient arrangement such as radial gates. Some action in this direction is already being taken. At the request of the Chief Engineer, a gate expert from the Bureau of Reclamation, Mr. Melvin Earmettler, viewed the project. His suggestions may be awaited. If and when a better solution is worked out, the only problem to implement the same will be the cost involved. Considering the importance and size of the project there may be good chances of getting some federal assistance.

CHAPTER VI - PRESENT WATER USE AND FUTURE POSSIBILITIES

General

Prior to the construction of the project, the State Water Conservation Board filed and recorded (reference: Book 3, Page 75 of Water Right Records, Broadwater County) a water right from Missouri River, dated June 28, 1938 in the amount of 16,000 miner's inches (400 cfs). However, the main canal is designed for 342 cfs. Thus, the present water right permits running the system at full capacity. Hydrologically, this quantity of water is always available at this site on the Missouri River. If the system were to run at full capacity, it can deliver 342 cfs x 5 months x 30 days x 2 Ac. ft./cfs day = 102,600 AC. ft. during the irrigation season, May 1 to September 30. Assuming 40% for losses, water that can actually be applied on the fields will be 61,560 ac.ft.

When the project was designed it was expected to supply 2 ac. ft./acre to 21,000 acres. Thus, it was expected to use 42,000 ac. ft. However, due to certain difficulties experienced in the beginning, some of the original contracts had to be dropped. Since then, there have been cancellations and additions to the amount of contracts under the project. At present, the contracts amount to 29,017.75 ac. ft. A list showing the names of the users and their contracted amount is found in Appendix II.

The contracts are in terms of ac. ft. and not in terms of acres. Most of the users also have rights on some of the creeks flowing through their farms. Thus, they apply water from both the creeks and the canal on their lands according to their convenience. Hence, it is difficult to pin down the acreage under the project.

Kelly's report (1960) estimated the acreage at that time to be 15,000. McDermott (1969) and Turnquist (1971) quoted from this report. The Water Resources survey of Broadwater County, prepared by State Engineer's office (1956) seems to have gone into greater detail. According to the maps shown in that report, it was estimated that "in 1955, 11,478 acres were being irrigated or supplemented with water from the Broadwater-Missouri Diversion Project. Approximately 979 acres are potentially irrigable under the present existing ditch system" (page 27 of Broadwater County Resources Survey).

Of course, since this report there have been several changes in the irrigation patterns. With the advent of sprinkler irrigation and pumping, areas which are at higher elevation and hence not considered accessible under the canal are being brought into the system. With a view to get an accurate and up to date idea of the area under irrigation, questionnaires (Appendix III) have been sent to all the water users. The time available for this study is so short that it was not possible to receive and compile all the replies. It is expected that the Board will pursue this and ultimately prepare a map of the area under irrigation. From this map it is planned to locate potential areas which can be brought into the system. Recent studies made on the Tongue River Project should be helpful in this work.

There is water available in the system and there should be no difficulty to accomodate several more new contracts. Of course, some sort of rotation system has to be worked out, to avoid peak demand in a single week or so, and leaving the system under-used at other times.

It should not be very difficult to work out some such rotation system, with the help of the local Soil Conservation Service experts of the U. S. Department of Agriculture.

Reviving the areas under irrigation between Duck Creek and Confederate Creek

As mentioned earlier,originally the canal extended to Confederate Creek. Information with regard to reasons for abandoning the reach between Duck Creek and Confederate Creek is not clear from the available records. However, it is understood that the reach was abandoned due to slippage and unduly high maintenance costs. The reach was inspected, with a view to explore possibilities of reviving this part of the canal. While location of actual areas of potential use has to await preparation of the proposed map of irrigation, it can be roughly estimated that about 1,000 acres more can be brought under irrigation in this area. From the land classification maps prepared in the Board office, it appears that some of these lands can be classified as high as class 2 or class 3 (on a scale of 1 to 6 with respect to suitability for irrigation). After the relevent areas are actually located on an up to date map, further investigation with regard to ownership and the plans of the present owners with regard to the use of these lands have to be conducted. Some of the potential land located by visual inspection is at present left as dry pasture land. There is a good possibility that the owners of these lands will be willing to irrigate them, if water is available. An economic analysis with regard to possible benefits and costs by reviving this canal can be done, after the above steps are taken on a more formal basis. Though in the limited time available, it was not possible to do any better on location of potential areas for water use, it is hoped that the ideas presented here will stimulate further formal work by the Water Resources Division.

Water Measurement

Unlike many other projects in Montana, most users in this project have facilities to meter water at their turnouts. Earlier,measurements of water supplied were not made. This season the ditchriders are asked to collect regular data on the quantity of water supplied to each user.

The records collected this season (ending September 30, 1972) should be very helpful in being able to identify possible additional areas of irrigation, system of rotation among the existing users, etc., resulting in optimum use of the system.

CHAPTER VII - OPERATION AND MAINTENANCE PRACTICES

General

Operation and maintenance of the Broadwater-Missouri Project follows the general pattern of other projects in Montana. The Broadwater-Missouri Water Users' Association is responsible for the operation and maintenance. There are two permanent employees of the association, a dam tender and a ditchrider. The dam tender looks after the maintenance of the dam and the west canal, whereas the ditchrider is responsible for maintenance of the east canal. In addition a part time secretary attends to the correspondence, bookkeeping, etc. This method seems to be working allright except for the limitation already mentioned that recognition and remedy of major problem areas has to be handled by people with the required know-how and facilities.

The Water Resources Board and the Soil Conservation Service of the U. S. Department of Agriculture have been responding to specific requests for technical and financial help. Some of the major maintenance works undertaken include lining of 2,240' of the main canal which was completed in 1967. Presently on the advice of the Water Resources Board, the SCS is conducting the necessary surveys and design for lining of the entire main canal. Actual construction is expected to start very soon.

A general assessment of the condition of the existing structures has been given in chapter IV with suggestions for necessary improvements. As may be observed from that chapter, for a project 30 years old, the condition of the system is very good. With the minor repairs suggested, the present structures should be useful for a considerable time into the future. It is difficult to give an estimate of the expenditure involved in this kind of repair work in the short time available for this study. However, as most of the repairs are minor (replacement of rotten wooden planks in bridges, etc), it should not be a costly project. Also, some repairs of bridges, etc. have to be paid for by the individual farmers who use them.

The need for new structures has been discussed in chapter V. As suggested there, the only structure that needs to be constructed in the near future is the siphon at Six Mile Creek crossing the east canal. Regrading needed on the 4-mile reach between Six Mile Creek and Dry Creek is maintenance work. Again due to the nature of work involved and the limitations of time, it is hard to give an exact cost estimate. As shales for the channel improvement are available in the nearby hills and the ditchriders' services are available for this maintenance work, this regrading work should not cost much. The Water Resources Division will, of course, provide the required know-how and inspection of the actual construction and repairs suggested above.

Economic Studies

It was suggested by the Legislative Audit that a factual determination of the past, present and future direct and indirect benefits from each project, should be done. In this connection it may be useful to refer to the following two studies on the economics of the Broadwater-Missouri Project.

1. "An Economic Analysis of Selected Montana State Water Conservation Board Projects." by Elroy C. McDermott, 1964.

2. "An Ex-Post Economic Evaluation of Montana Water Resources Board Projects." WICHE Project by Mr. Bill Turnquist, 1971.

Both these reports have considered the Broadwater-Missouri Irrigation Project, and their relevent observations are presented here.

Mr. E. C. McDermott conducted a study of the impact of the Project on the local economy. The study included investigation of land prices, growth of banking and other business in the area, higher tax base after construction of the project and public reaction in general to the project. The summary and conclusions of this study are as follows:

1. *Irrigation is of utmost importance to Broadwater County and is a stabilizing factor in assuring income from the sale of cash crops and abundant winter feed.*

2. *The Broadwater-Missouri Project is probably the most important irrigation project in the county. It serves approximately 15,000 acres, of which approximately 7,000 acres receive a primary supply and approximately 8,000 acres receive a supplementary supply.*

3. *The project has made possible the production of such cash crops as sugar beets and potatoes, thus affording the water users an opportunity to increase their net returns per acre.*

4. *Risk and uncertainty have been greatly reduced as a result of the project. Yields have been approximately doubled in normal years on those areas receiving a supplementary supply. In particularly dry years they are now assured of a crop, whereas little or no crop could have been harvested without the project water.*

5. *The level of living of farm families in Broadwater-County has been relatively favorable during the past three decades, compared to the level of living of farm families in the state as a whole and also the nation.*

6. *The average value of irrigated project land was $193.22, while land of similar quality and fertility but which could not be irrigated, was $19.06. The addition of water to lands of similar quality has increased their value approximately $170 per acre. This difference in price should represent the capitalized value of the net returns to the water discounted over time.*

7. *The project has contributed considerably to the tax base of Broadwater County. It is assumed that one-fourth of the 7,000 acres brought under irrigation by the project were previously classified as non-irrigated tillable lands, with the remainder classified as grazing land. On this basis, the increase in the tax base would amount to approximately $204,347, consisting of an average increase of $23.41 per acre on 1,750 acres and $31.12 per acre on the remaining 5,250 acres. No attempt was made to evaluate the indirect additions to the tax base, such as more farm machinery and equipment, improvements, etc., nor the extent to which the state income tax base was broadened from the increased direct and indirect benefits.*

8. *In 1961, the net direct benefits from the project were approximately $264,847. This would represent direct benefits of $17.66 per acre for the acres being served by the project.*

9. *The net indirect benefits generated by the project in 1961 were approximately $356,543. This figure was derived through use of the direct to indirect benefit ratio computed by Holje, Huffman, and Kraenzel at Montana State College.*

10. *Net direct and indirect benefits from the project totaled approximately $620,000 in 1961. Based upon the conservative estimate of 50-year project life and assuming net annual benefits equal to those of 1961, then the total net benefits derived during the 50-year period would be approximately 31 million dollars.*

11. *Assuming the life of the capital structure to be 50 years and an annual net return of $620,000, the current value of the investment can now be determined. At a discount rate of 4% the current value would be 3.3 million dollars, at 5% it would be 11.3 million dollars and at 6% it would be 9.8 million dollars. The total project cost was approximately 1.2 million dollars at the time of construction. In 1961 construction costs were approximately 4.5 times as great as when the project was constructed, making project construction costs in 1961 dollars equal to approximately 5.4 million dollars. This analysis indicates that the project has a very favorable benefit-cost ratio. At a 4% discount rate it would be approximately 2.5 to 1, at 5% approximately 2.1 to 1 and 6% it would run approximately 1.9 to 1.*

12. *The majority of the water users and local people who were interviewed, expressed real satisfaction with the project. With the exception of a few minor complaints, the general local attitude was one of support and praise.*

Mr. Turnquist has conducted an ex-post analysis of benefits and costs of the project from the project inception to 1971. One of the main difficulties faced was to isolate the areas of irrigation under the project and to estimate the contribution of irrigation water in areas receiving supplemental irrigation. Mr. Turnquist assumed two levels of contribution of supplemental irrigation;10% (lower) and 50% (higher). The benefit-cost ratios he got for 2%, 5%, and 8% interest rates are as below:

The Range of Benefit-Cost Ratios with Sensitivity Analysis, Based on an Ex-Post Analysis from 1940-1970, Broadwater- Missouri Project.

	i=2%	i=5%	i=8%
Lower Assumed Benefits	2.17	1.33	0.86
Higher Assumed Benefits	5.54	3.39	2.21

From the above studies it is clear that this project has a very favorable benefit-cost ratio. During personal discussions with the farmers, the writer also got the impression that they are very pleased with the stability introduced by this project in their agricultural operations and the economy in general. Thus, in response to the legislative audit, it can safely be said that this is a very useful project and should be kept up in good condition, thereby allowing the same level of benefits, or possibly greater, to accrue in the future.

*Financial Analysis

Construction costs on the project came mainly from federal grants and loans apart from some State investment. The Federal Public Works Administration made a loan and grant agreement with the board on November 2, 1938. Under this agreement the federal government bought $495,000 in bonds issued by the state and $405,000 was authorized making the total federal funds available $958,000. The following table shows the break down of construction costs.

		Federal Funds	State Funds	Total
Right of Way		$ 26,660.77	$ 8,286.54	34,947.31
Construction				
Contracts -				
Utah Cons. Co.	$730,227.80			
Douglas and Genger	152,754.85			
N. P. Ry. Co.	8,109.35	891,092.00		891,092.00
Construction				
Other			42,195.13	42,195.13
Damtender's Salary			24,870.00	24,870.00
Ruby W. U. A.			7,800.00	7,800.00
Advances to Ass'n			13,027.66	13,027.66
Engineering		10,572.63	103,628.88	114,201.51
Legal & Administration		2,124.60	16,818.36	18,942.96
Administration Charge			11,322.67	11,332.67
Int. During Construction		28,050.00		28,050.00
		$ 958,500.00	227,949.24	1,186,449.24

From the preceding paragraph and the above chart it may be seen that the state needs to recover $495,000(bond sale) + $227,949.24 (State investment) = $722,949.24 from the water users. In 1951, the Board bought all outstanding bonds from the federal government at a concessional rate. The prorated share of the Broadwater-Missouri Project of the outstanding debt was $184,186 (see page 21 of audit report). Hence the total owing from the water users would reduce to $227,949.00 + $184,196.00 = $412,145.00. However, in 1951 the Board allocated the bond amount they purchased from the federal government on the basis of ability to pay, instead of on a prorated basis. On this basis, the board allocated $420,000.00 to be the share of the Broadwater-Missouri Water Users . According to this the amount due was $227,949 + $420,000.00 = $647,949.00.

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* The figures mentioned in this section are obtained from the Accounting section of Water Resources Division and Robert J. Kelly "Summary of activities from inception to June 30,1960."

Revenue to June 30, 1972 was $557,402.(a) An amount of $132,591.00 is expected to be collected from the existing contracts. With the board's decision in 1951 to collect $420,000.00 from this project, on the basis of ability to pay, there is likely to be $42,044 over-recovery.

Operation and Maintenance Costs

Until 1960, operation and maintenance costs were not accounted for separately. Since 1960, the state has spent $71,887.00,(b) up to June 30, 1972 on operation and maintenance of this project. This represents $49,463.00 of advances paid for major repair and improvement works and $22,464.00 spent mostly on payroll and per diem expenses of state employees for their work on problems connected with the project. The $49,463.00 representing loans on maintenance works was completely repaid by the Association, as of June 30, 1972. The payroll and per diem expenditure of $22,426.00 is still shown as owing according to the books of the board. It may be relevent to note that this kind of expenditure has not been collected from most of the other projects in the State as well. In fact, in January 1970, the board made a policy decision to the extent that "Engineering costs are not to be included in project costs."

Thus, it may be seen that this project has been on a sound footing in terms of operation and maintenance expenses also.

(a)	Revenue to June 30, 1970 (as per audit report)	502,214
	Revenue between June 30, 1970 to June 30, 1972 (As per books of Accounts Section)	49,188
	TOTAL	557,402

(b)	Cost up to June 30, 1970 (as per audit report)	69,217
	Cost from June 30, 1970 to June 30, 1972 (As per books of Accounts Section)	2,670
	TOTAL	71,887

CHAPTER VIII - SUMMARY AND RECOMMENDATIONS

Chapter I. Purpose and Scope

1. The Water Resources Division of the Montana Department of Natural Resources and Conservation is concerned with management of about 33 small irrigation projects. Between the extremes of leaving the operation and maintenance entirely to water users' associations and taking over the responsibility entirely on itself, the "critique' method is suggested as a reasonable and practical compromise.

2. This study evolved out of the recommendations of the Legislative Audit, 1971. Emphasis is laid on answering the technical observations, while briefly touching on financial and administrative recommendations of the audit.

3. Due to limitations on time only one project, Broadwater-Missouri Diversion Project, is studied here. However, the methodology deeloped here is applicable to all other projects as well.

Chapter II. Montana Water Resources Board

4. This chapter traces the history of the formation and the policies followed by the Montana Water Resources Board (predecessor to the present Water Resources Division).

Chapter III. Broadwater County.

5. The Broadwater-Missouri Diversion Project, has a great impact on the life in general of Broadwater County. A general description of the climate, transportation, income and levels of living, farming practices, etc., in the county, is presented in this chapter. Most of the observations in this chapter are applicable to the area served by the project.

Chapter IV. Broadwater-Missouri Diversion Project - Assessment of Existing Structures

6. Each of the existing structures in the project was inspected and rated for its general condition and projected life. Where necessary, recommendations are made for repair or replacement.

Chapter V. Need for New Structures

7. A preliminary discussion was held with the water users to locate areas causing concern to them.

8. These problem areas were visited and the necessary data was gathered and analyzed to suggest solutions aimed at improving the working of the system.

9. A siphon structure has to be constructed at the crossing of the east canal with Six Mile Creek. The siphon may be designed for 50 to 100 cfs to carry the creek under the canal. The rest of the design flow (150 to 200 cfs) may be handled through an emergency spillway.

10. The reach between Six Mile Creek and Dry Creek has to be regraded. This

can be done with locally available shales. It is advisable to carry out these repairs after the construction of the structure at Six Mile Creek crossing, as one of the reasons for the loss of grade in this area is the interference of the debris brought by Six Mile Creek into the system.

11. At the site of Crow Creek crossing the west canal, no structural solution seems necessary. The present situation may be met by implementing the suggestions given in Chapter V.

12. The reverse flow being observed on the spillway at the Deep Creek crossing of the east canal is due to the obstructions in the creek downstream of the crossing. These obstructions may be cleared and the results observed next spring. If reverse flow is observed even then, a detailed hydraulic study of the entire area has to be undertaken on maps showing levels of the creek, spillway, surplus channel, etc. Deepening the creek or some such measure should solve the problem. No structural solution appears necessary.

13. The gates on the dam are of an antiquated design. It is preferable to replace them with a system that can be operated easier. The advise of the gate expert of the Bureau of Reclamation, who visited the project, is awaited.

Chapter VI. Present Water use and Future Possibilities

14. The system has a capacity to supply more water than is contracted for. This surplus water can be sold to the present users who express a desire to buy more water.

15. The present water contracts should be tied down to the area where it is being applied. The answers to the questionnaire circulated to the users should be helpful in this regard.

16. Once the present area of irrigation is located, potential areas that can be brought under irrigation can be explored.

17. With the help of SCS and in consultation with the users it is possible to work out a system of rotation for supply of water, enabling coverage of additional areas by the canal.

18. After the above investigations are completed, if there is still surplus water, the economics of reviving the abandoned portion of the east canal between Duck Creek and Confederate Creek may be considered.

19. This year (1972) regular measurements are being made of the water supplies at each turnout. Such data should be collected on a regular basis hereafter. This data will be very useful in working out plans of rotation for supply of water, etc.

Chapter VII. Operation and Maintenance Practices

20. Economic studies made by Mr. Elroy C. McDermott and Mr. Bill Turnquist, indicate a very favorable benefit-cost ratio in this project.

21. In general, the project has contributed to the economic and agricultural

stability of the Broadwater county. All the water users and others affected by the project express a sense of satisfaction and are willing to keep it running in good condition.

22. The level of living of farmers in the area has increased considerably since the construction of the project. Farmers in this area enjoy a higher level of living than the average in Montana and the U.S.A. (relevent statistics are presented in Chapter III.)

23. Considering the present balance sheet, by implementing the present contracts in full, it is possible to recover all state expenses on the construction of the project.

24. All advances given to the water users for operation and maintenance of the project have been repaid. Some expenses (mainly payroll and per diem expenses) are still shown due from the water users' association. Such expenses have not been recovered from other projects also. However, these expenses will have been recovered when all present contracts have been paid.

General.

25. This critique should be updated once every two (2) years.

26. While the critique should be updated regularly, the board should continue to attend to any emergency requests from the water users' associations. However, regular updating of the critique and prompt implementation of the suggestions made after a critique will minimize such emergencies.

-REFERENCES-

1. "Report on Examination of the Water Resources Board for Fiscal Year Ended June 30, 1970". Office of the Legislative Auditor, State of Montana, Helena, 1970.

2. "State Water Conservation Board: Summary of Activities from Inception January 22, 1934 to June 30, 1960" by Robert J. Kelly, Administrative Officer, Montana State Water Conservation Board, Helena, Montana, 1961.

3. "Water Resources Survey: Broadwater County", published by State Engineer's Office, Helena, Montana 1956.

4. "An Economic Analysis of Selected Montana State Water Conservation Board Projects" by Elroy C. McDermott. Department of Agricultural Economics, Montana State University, Bozeman, Montana, 1964.

5. "Farm Operator Level of Living Indexes for Counties of the United States", May 1952 and Statistical Bulletin No's. 204, March 1957; 321, September 1962; and 406, June 1967.

6. "Montana Agricultural Statistics, Vol. XIII: County Statistics 1968 and 1969", published by the Montana Department of Agriculture and Statistical Reporting Service - U. S. Department of Agriculture, 1970.

7. "Montana Census of Agriculture, 1969, Selected County Summaries of Farm and Ranch Characteristics", Reprinted by Montana Crop and Livestock Reporting Service, Helena, Montana.

8. "An Expost Economic Evaluation of Montana Water Resources Board Projects" by William H. Turnquist - WICHE Project 1971, Published by the Water Resources Division, Department of Natural Resources and Conservation, Helena, Montana, 1972.

9. "Broadwater County Situation Statement 1972" Prepared by Broadwater County U.S.D.A. Committee for Rural Development, Townsend, Montana, 1972.

10. "Soil Survey of Broadwater County" to be published by Soil Conservation Service, U. S. Department of Agriculture, Helena, Montana, 1972.

11. "Water Resources Data for Montana, Part 1 - Surface Water Records", Published by the U. S. Geological Survey, 421 Federal Building, P. O. Box 1696, Helena, Montana.

12. "Magnitude and Frequency of Floods from Drainage Areas Less Than 100 Square Miles in Montana", by F. C. Boner and R. J. Omang, U. S. Geological Survey open-file report, Helena, Montana, 1967.

13. "Indirect Benefits of Irrigation Development: Methodology and Measurement.", Holje, H. C. Huffman, R. A. , and Kraenzel, C. A., Bulletin # 517, Montana State College Agricultural Experiment station, Bozeman, MT 1956.

CANAL OR DITCH: Broadwater-Missouri Diversion Canal

LOCATION CODE NOTES: 1 - M - 7
Structure No. ↑ Section
M - Main Canal Main Canal
E - East Canal
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APPENDIX I

SURVEYED BY: Eric Hansen and Gary Wiseman

LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
1-E-31	Syphon Outlet		Concrete	Good	20	
2-E-31	Walkway	30'	Wood	Good	5	
3-E-31	Wasteway	50' long 6' wide 4' BW	Concrete	Good	20	
4-E-36	Bridge	45' long 20' wide	Wood	Good	10	
5-E-36	T.O.	24'	Concrete	Good	20	
6-E-26	T.O.	24"	Concrete	Good	20	
7-E-26	Bridge	45'	Concrete Wood	Good	20	
8-E-26	T.O.	24"	Concrete	Good	20	
9-E-23	Walkway	45'	Wood	Poor	1	Wooden planks need replacement
10-E-23	T.O.	18"	Concrete	Good	20	
11-E-23	T.O.	12"	Concrete	Good	20	

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LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
12-E-23	Field Drain	10"	CMP	Good		
13-E-23	Pump 10" pipe	10"	Steel	Good		
14-E-23	Bridge	50'	Wood	Good	10	
15-E-23	Bridge	30'	Wood	Good	10	
16-E-23	Pump	8" x 8"	Wood & Concrete	Good	10 20	
17-E-23	Walkway	40'	Wood	Fair	5	
18-E-23	T.O.	24"	Concrete	Good	20	
19-E-23	Check	35'	Concrete	Good	20	
20-E-14	Bridge	30'	Wood & Concrete	Good Good	10 20	
21-E-14	T.O.	18"	Concrete	Good	20	
22-E-14	T.O.	24"	Metal	Good		

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LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
23-E-14	T.O.	30' width 24" opening	Concrete	Good	20	
24-E-14	Pump	8" pipe		Good		
25-E-14	T.O.	24"	Metal	Good		
26-E-14	6 mile Creek	NO	STRUCTURE			New structure proposed in Chapter V.
27-E-14	6 mile Creek Outlet	60' 3-4' gates	Concrete & Wood	Good Good	20 7	
28-E-14	T.O.	18"	Concrete	Good	20	
29-E-14	Check	45' 3-5' gates	Concrete & Wood walkway	Good Fair	20 4	
30-E-14	Bridge	27'	Concrete & Wood	Good Good	20 10	
31-E-11	T.O.	18"	Concrete	Good	20	
32-E-11	T.O.	18"	Concrete	Good	20	
33-E-11	Pump					

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LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
34-E-11	Bridge	40'	Wood	Fair	5	
35-E-11	T.O.	18"	Concrete	Good	20	
36-E-11	Check	45' 1-15' opening	Concrete	Good	20	
37-E-11	Pipe Field Drain	12"	Metal	Good		
38-E-11	T.O.	24"	Concrete	Good	20	
39-E-2	T.O.	24"	Concrete	Good	20	
40-E-2	Check	3-5' gates 50'	Concrete	Good	20	
41-E-2	Field Drain	18"	Metal	Good		
42-E-2	Bridge	35'	Wood with steel center support	Fair	5	
43-E-2	Field Drain	18"	CMP	Good		
44-E-2	T.O.	18"	Concrete	Good	20	

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LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
45-E-2	T.O.	24"	Concrete	Good	20	
46-E-2	Field Drain	18"	CMP	Good		
47-E-35	Bridge	27'	Concrete & Wood	Good Fair	20 3	
48-E-35	T.O.	18"	Concrete	Good	20	
49-E-35	Check	45' 3-5' gates	Concrete	Good	20	
50-E-35	Field Drain	18"	CMP	Good		
51-E-35	T.O.	24"	Concrete	Good	20	
52-E-35	Field Drain	18"	CMP	Good		
53-E-35	T.O.	12"	Concrete	Good	20	
54-E-35	Pump		Concrete	Good		
55-E-35	Pump					

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LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
56-E-26	T.O.	18"	Concrete	Good	20	
57-E-26	Check	3-5' gates 45'	Concrete	Good	20	
58-E-26	Flume		Wood	NOT USED		
59-E-26	T.O.	18"	Concrete	Good	20	
60-E-26	Creek Outlet	2-5' gates 60'	Concrete	Good	20	
61-E-26	T.O.	18"	Concrete	Good	20	
62-E-26	Siphon	48"	Concrete	Good	20	
63-E-26	T.O.	18"	Concrete	Good	20	
64-E-26	Check	3-5' gates 50"	Concrete	Good	20	
65-E-26	Bridge	35'	Wood	Fair	4	
66-E-26	T.O.	24"	Metal	Good		

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LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
67-E-26	Flume	18"	CMP	Good		
68-E-26	Bridge	25'	Concrete Wood	Good Poor	20 1	Wooden planks need replacement
69-E-26	T.O.	18"	Concrete	Good	20	
70-E-22	Siphon	36"	Concrete	Good	20	
71-E-22	T.O.	18"	Concrete	Good	20	
72-E-22	Siphon	48"	Concrete	Good	20	
73-E-22	T.O.	18"	Concrete	Good	20	
74-E-22	T.O.	18"	Concrete	Good	20	
75-E-22	Flume	24"	CMP	Good		
76-E-22	Field Drain	12"	CMP	Good		
77-E-22	T.O.	1 metal gate 18' 2 head-board gates	Concrete	Good	20	

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LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
78-E-15	Bridge	20'	Concrete Wood	Good Good	20 8	
79-E-15	Bridge over Creek and Creek inlet	6' x 25'	Concrete Wood Steel	Good Good Good	20 10	
80-E-15	Check	3-5' gates 50'	Concrete	Good	20	
81-E-15	Walkway	40'	Wood	Poor	1	Needs replacement
82-E-15	Small Pump	3/4" pipe	Metal	Good		
83-E-15	T.O.	18"	Concrete	Good	20	
84-E-15	Wasteway	3-5' gates 50'	Wood Concrete	Good	5 20	
85-E-15	Check	3-5' gates 50'	Concrete	Good	20	
86-E-15	Flume	60' 24"	CMP	Good		
87-E-15	To Wasteway	1 metal gate 1 headboard gate 12'				
88-E-15	to & pump	12" to	Concrete	Good	20	

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LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
89-E-15	Bridge	30'	Concrete Wood	Fair	10 5	
90-E-15	Headgate to	24"	Concrete	Good	20	
91-E-15	Pump	8"				
92-E-15	T.O.	24 x 24	Metal with M. device	Good		
93-E-10	Bridge	40' x 25'	Wood	Good	10	
94-E-10	T.O.	24 x 24	Metal	Good		
95-E-10	Check	40'	Concrete	Good	20	
96-E-10	Wasteway & T.O.	20'	Concrete & Timber	Good Poor	20 0	Wooden planks need replacement
97-E-10	T.O.	24" x 24"	W. meas. device Metal	Good	20	
98-E-10	Pump	8"	Electric			
99-E-10	Flume	18"	CMP	Good		

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LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
100-E-10	Flume	18"	CMP	Good		
101-E-10	Bridge	25' x 12'	Wood	Fair		
102-E-10	T.O. & Check	24 x 24 40'	Wood Concrete Wood	Fair Good Fair	2 20 2	
103-E-10	Syphon	36"	Concrete	Good	20	
104-E-10	Flume	18"	CMP	Good		
105-E-10	Bridge	15'	Concrete & wood	Good Good	20 5	
106-E-10	Inlet	3' x 4'	Concrete	Good	20	
107-E-10	T.O. Drop	24 x 24	Metal & Concrete	Good Good	20 20	
108-E-4	T.O.	24 x 24	Concrete WMD Metal	Good	20	
109-E-4	T.O.	24 x 24	WMD Concrete Metal	Good	20	
110-E-4	T.O.	24 x 24	WMD Concrete Metal	Good	20	

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LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
111-E-4	T.O.	18" x 18"	WMD concrete Metal	Good	20	
112-E-4	Pump	8"				
113-E-4	T.O.	30" x 30	WMD Concrete Metal	Good	20	
114-E-4	T.O.	24 x 24	WMD Concrete Metal	Good	20	
115-E-4	Culvert under road	6'	CMP	Good	20	
116-E-34	T.I.	WMD 24 x 24	WMD Metal	Good	20	
117-E-34	T.O.	24 x 24	WMD Metal	Good	20	
118-E-34	Pump	4"				
119-E-34	Bridge	30'	Wooden	Good	10	
120-E-34	Pump	8"				
121-E-34	Pump	8"				

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LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
122-E-34	Check	40'	Concrete	Good	20	
123-E-24	Foot bridge	40'	Wood	Good	5	
124-E-27	Pump	8"				
125-E-27	Pump	10"				
126-E-27	Foot Bridge	40'	Wood	Good	5	
127-E-27	Pump	10"				
128-E-27	T.O. & Drop	24" x 24" 24" x 36"	NOT USED			
129-E-22	Pump	4"				
130-E-22	Pump	4"				
131-E-22	Pump	4"				
132-E-22	T.O.	24 x 24	Concrete WMD Metal	Good	20	

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LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
133-E-22	T.O.	36" x 24"	Concrete WMD Metal	Good	20	
134-E-22	T.O.	24 x 24	Concrete WMD Metal	Good	20	
135-E-22	Bridge	40'	Concrete & Wood	Good	20 5	
136-E-15	T.O.	24" x 24"	Concrete WMD Metal	Good	20	
137-E-15	T.O.	24 x 24	Concrete WMD Metal	Good	20	
138-E-15	Pump	6"				
139-E-15	Wasteway	20'	Concrete & Wood	Good Good	20 5	
140-E-15	T.O.	24" x 24"	Concrete WMD Metal	Good Good	20 20	
141-E-15	Check	40"	Concrete	Good	20	
142-E-15	T.O.	24" x 24"	Metal WMD Concrete	Good Good	20 20	
143-E-15	Bridge	30'	Concrete & Wood	Good Good	20 5	

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LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
144-E-15	T.O.	24 x 24	WMD Concrete Metal	Good	20	
145-E-11	T.O.	24 x 24	WMD Concrete Metal	Good	20	
146-E-11	Check	30'	Concrete	Good	20	
147-E-11	Wasteway T.O.	20' 24 x 24	Concrete WMD Metal	Good Good	20 20	
148-E-11	T.O.	24 x 24	WMD Concrete Metal	Good	20	
149-E-11	Check	30'	Concrete	Good	20	
150-E-11	Bridge	30'	Concrete & wood	Good Good	5 20	
151-E-11	T.O.	24"	Concrete WMD Metal	Good Good	5 20	
152-E-2	Bridge	20'	Concrete & wood	Good Good	20 5	
153-E-2	Pump	4"				
154-E-2	T.O.	24 x 24	Conc Metal	Good	20	

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LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
155-E-2	Bridge	30'	Wood	Poor	0	
156-E-2	Flume	6"	CMP	Fair	5	
157-E-2	Pipe under canal	30"	CMP	Good	20	
158-E-2	T.O.	2-18" pipe	CMP	Good	20	
159-E-2	Check	30'	Concrete	Good	20	
160	Bridge	30'	Wood	Good	5	
161-E-2	Flume	12"	CMP	Fair	5	
162-E-2	T.O.	24 x 24	Concrete	Good	20	
163-E-2	Wasteway	30'	Concrete	Good	20	
164-E-2	T.O.	24 x 24	Concrete WMD	Good	20	
165-E-2	T.O.	24 x 24	Concrete WMD	Good	20	

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LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
165-E-35	T.O.	24 x 24	Concrete WMD	Good	20	
166-E-35	T.O.	24 x 24	Concrete WMD	Good	20	
167-E-35	T.O.	24 x 24	Concrete WMD	Good	20	
168-E-35	T.O.	24 x 24	Concrete WMD	Good	20	
169-E-35	T.O.	24 x 24	Concrete WMD	Good	20	
170-E-35	Concrete Pipe under	5'	Concrete	Good	20	
171-E-35	Bridge	20'	Concrete & Wood	Good Good	20 5	
172-E-35	Culvert under road	90' L 6' Dia.	CMP	Good	20	
173-E-27	T.O.	24 x 24	Concrete WMD	Good	20	
174-E-27	Bridge	20'	Concrete & Wood	Good Good	20 5	
175-E-27	Bridge	20'	Concrete & Wood	Good Good	20 5	

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LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
176-E-27	Flume	12"	CMP	Good	20	
177-E-27	T.O.	24 x 24	Concrete WMD	Good	20	
178-E-27	Check	30'	Concrete & Wood	Good Good	20 5	
179-E-27	T.O.	24 x 24	Concrete WMD	Good	20	
180-E-27	Check	30'	Concrete	Good	20	
181-E-27	Bridge	30'	Wood	Good	5	
182-E-27	Wasteway	40'	Concrete	Good	20	
183-E-27	Check	30'	Concrete	Good	20	
184-E-21	T.O.	24"	WMD Concrete	Good	20	
185-E-21	T.O.	24"	WMD Concrete	Good	20	
186-E-21	Check	30'	Concrete	Good	20	

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LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
187-E-21	Bridge	30'	Wood	Good	7.5	The gate needs fixing or replacement
188-E-21	T.O.	24"	Concrete	Good	20	
189-E-21	Pipe	35"	Concrete	Good	20	
190-E-21	Pump	6"				
191-E-21	T.O.	24"	Concrete	Good	20	
192-E-21	T.O.	24"	Concrete	Good	20	
193-E-21	Bridge	30'	Concrete	Good	20	
194-E-21	T.O.	24"	Concrete	Good	20	
195-E-21	Check	30"	Concrete	Good	20	
196-E-16	T.O.	24"	Concrete	Good	20	
197-E-16	Check	30'	Concrete	Good	20	

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LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
198-E-16	T.O.	24"	Concrete	Good	20	
199-E-16	Check	30'	Concrete	Good	20	
200-E-16	Underpass	36"	Concrete	Good	20	
201-E-9	T.O.	24"	Concrete	Good	20	
202-E-9	Check	30'	Concrete	Good	20	
203-E-9	Canal xing	30"	CMP	Good	20	
204-E-9	T.O.	24"	Concrete	Good	20	
205-E-9	Wasteway	24"				
206-E-9	Siphon	24"	Concrete	Good	20	
207-E-9	Flume	12"	CMP	Good	20	
208-E-9	T.O.	24"	Concrete	Good	20	

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LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
209-E-5	Canal xing	18"	CMP	Good	20	
210-E-5	Canal xing	18"	CMP	Good	20	
211-E-6	Drop	27"	Concrete	Good	20	

CANAL OR DITCH: Broadwater-Missouri Diversion Canal

LOCATION CODE NOTES: 1 - M - 7
Structure No. ↑ Section
Main Canal

APPENDIX I

M - Main Canal
E - East Canal
W - West Canal

SURVEYED BY: Eric Hansen and Gary Wiseman

LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
1-M-7	River Diversion	4-4' x 7' slide gate	Concrete	Good	50	
2-M-7	Canal Diversion	14' radial 8' radial	Concrete	Good	50	
1-W-31	Bridge	Width=12'	Metal beam Concrete	Good	25+	
2-W-31	Walkway	3' x 25'	Timber	Good	7	
3-W-31	Syphon Inlet	4'	Pipe Concrete	Good	25+	
4-W-36	Syphon Outlet	4' Pipe 5' BW	Concrete	Good	25+	
5-W-36	Farm Bridge	25'	Timber	Good	7	
6-W-36	T.O.	18"	Concrete	Good	10	
7-W-35	Wasteway	50' Wide	Concrete	Good	25+	
8-W-35	Check	8'-BW	Concrete	Good	25+	
9-W-35	Culvert	30"	Concrete	Good	25+	

CANAL OR DITCH: Broadwater-Missouri Diversion Canal

LOCATION CODE NOTES: 1 - M - 7
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SURVEYED BY: Eric Hansen and Gary Wiseman

LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
10-W-36	Wasteway Culvert	4'	Concrete	Good 48" pipe	25+	
11-W-26	Farm Bridge	25'	Metal Beams Concrete	Good	10	
12-W-26	T.O. Check	1 8'-BW	Concrete Concrete	Good Good	20+ 25+	
13-W-27	T.O.	24"	Concrete	Good	25	
---------	pump in ditch----------					
14-W-27	T.O.	24"	Concrete	Good	20+	
15-W-27	Wasteway	50' wide	Concrete	Good	25+	
16-W-27	Check	BW=8'	Concrete	Good	20+	
17-W-27	Syphon	30"	Concrete	Good	20+	
18-W-27	T.O.	24"				
19-W-27	Wasteway	30'	Concrete	Good	20+	
20-W-27	T.O.	34"	Concrete	Good	20+	

CANAL OR DITCH: Broadwater-Missouri Diversion Canal

LOCATION CODE NOTES: 1 - M - 7
Structure No. ↑ Section N
Main Canal

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APPENDIX I

SURVEYED BY: Eric Hansen and Gary Wiseman

LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
21-W-27	T.O.	18"	Concrete	Good	20+	
22-W	Bridge	12' wide	Wood rack Concrete	Good	20+	
23-W	Flume	18"	CMP	Good	10+	
24-W	Check T.O.	BW=8' 24"	Concrete Concrete	Good Good	20+ 10+	
25-W-28	Pump house	10"	Concrete Footings	Good	10	
26-W-28	Farm Bridge	20'	Timber Concrete	Good Good	7 20	
27-W-28	T.O.	24"	Concrete	Good	20+	
28-W-28	Pump house	3" outlet				
29-W-28	T.O.	18"	Concrete	Good	20+	
30-W-28	T.O.	24"	Concrete	Good	20+	
31-W-28	Pump house	10"	Wood House		10+	

CANAL OR DITCH: Broadwater-Missouri Diversion Canal

LOCATION CODE NOTES: 1 - M - 7
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APPENDIX I

SURVEYED BY: Eric Hansen and Gary Wiseman

LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
32-W-28	Wasteway	50'	Concrete		20+	
33-W-28	Check	6'=BW	Concrete	Good	10+	
34-W-29	Wasteway	20'	Concrete	Good	15+	
35-W-29	Wasteway	20'	Concrete	Good	15+	
36-W-29	Siphon	24"	CMP	Good	15+	
37-W-29	Check	30'	Concrete	Good	20	
38-W-29	Flume	2' x 2'	Wood	Poor	0	Needs replacement
39-W-29	T.O.	24"	Concrete	Good	20	
40-W-29	Pump	8"	Metal	Poor	0	Not used
41-W-29	Bridge	30'	Wood	Poor	2	Needs replacement
42-W-29	Pickup	24"	CMP	Fair	12	

CANAL OR DITCH: Broadwater-Missouri Diversion Canal

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APPENDIX I

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LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
43-W-29	Wasteway	20'	Concrete	Good	20	
44-W-20	Check	20'	Concrete	Good	20	Wooden planks need replacement
45-W-20	Flume	18"	Pipe	Fair	10	
46-W-20	Flume	18"	Pipe	Fair	10	
48-W-20	Wasteway	40'	Concrete	Good	20	
49-W-20	Check	30'	Concrete	Good	20	
50-W-20	Siphon	30"	CMP	Good	20	
51-W-20	Bridge	20'	CMP & Wood	Good	20	
52-W-20	Wasteway	40'	Concrete	Good	20	
53-W-20	Check	30'	Concrete	Good	20	
54-W-20	Bridge	16'	CMP	Good	20	

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LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
55-W-20	T.O.	24" x 24"	WMD Concrete	Good	20	
56-W-17	T.O.	24" x 24"	WMD Concrete	Good	20	
57-W-17	Bridge	16'	CMP	Good	20	
58-W-17	Check	30'	Concrete	Good	20	
59-W-17	T.O.	24" x 24"	Concrete	Good	20	
60-W-17	Bridge	30' W	Wood Concrete	Poor Good	2 20	Wooden planks need replacement
61-W-8	T.O.	24" x 24"	Concrete	Good	20	
62-W-8	Bridge	10'	CMP	Good	20	
63-W-8	T.O.	24" x 24"	WMD Concrete	Good	20	
64-W-5	Wasteway	15'	Concrete	Good	20	
65-W-5	T.O.	24" x 24"	Concrete	Good	20	

CANAL OR DITCH: Broadwater-Missouri Diversion Canal

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APPENDIX I

SURVEYED BY: Eric Hansen and Gary Wiseman

LOCATION CODE	TYPE OF STRUCTURE	CAPACITY OR SIZE	MATERIAL	CONDITION	LIFE (YEARS)	REMARKS
66-W-5	T.O.	24" x 24"	Concrete	Good	20	
67-W-5	Bridge	15'	CMP	Good	20	
68-W-5	T.O.	24" x 24"	Concrete	Good	20	
69-W-5	T.O.	12" x 12"	Concrete	Good	20	
70-W-32	T.O.	24"	CMP	Good	20	

Appendix II

BROADWATER-MISSOURI WATER USERS'

NAME	ACRE FEET	ADDRESSES
Jack Nelson	850	Townsend, MT 59644
Louis Anzik	140	Toston, MT 59643
Vera and Albert Arnett	100	Townsend, MT 59644
Mrs. Louise C. Galt	100	615 Helena, MT 59601
James Baxter	61	Toston, MT 59643
William F. Bentley	100	
(User-Larry Shearer)		Townsend, Montana 59644
William J. and Betty Lou Bieber		
(User-Lavern Newberg)	10	Toston, MT 59643
William L. Bieber	310	Townsend, MT 59644
Marie Bruce	250	Townsend, MT 59644
Wallace Bruce	225	Townsend, MT 59644
Peter Brug	22	Toston, MT 59643
Marion Bucy	200	Townsend, MT 59644
Raymond Tocci	330	Three Forks, MT 59752
Paul Carson	200	Townsend, MT 59644
Lyle B. Chamberlain	165	Townsend, MT 59644
Walter L. Clark	325	
(User-Don Wogoman)		Toston, MT 59643
C. C. Cowan	660	Box 1117 Idaho Falls, Idaho 83401
L. R. Dagnall	100	Townsend, MT 59644
D. D. Davis Ranch Co.	1393	Townsend, MT 59644
Albert Diehl	100	Winston, MT 59647
Curt Diehl	1090	Townsend, MT 59644
Andy Bruce	500	Townsend, MT 59644
Walter Ray Doig	110	Townsend, MT 59644
Maurice J. Ferratt	100	Toston, MT 59643
Frank Flynn	248	Townsend, MT 59644
William Flynn	1100	Toston, MT 59643
Harry F. Foster	165	Townsend, MT 59644
Harold A. Frey	320	Toston, MT 59643
Edna R. Gaab	500	Townsend, MT 59644
W. Booher	225	Townsend, MT 59644
Robert Hensley	600	Townsend, MT 59644
Herbert Hoppe	100	Townsend, MT 59644
Boyd Iverson	500	Townsend, MT 59644
Art Jersey	40	Toston, MT 59643
Byron Johnson	132	Toston, MT 59643
Mrs. Harry Johnson	10	Toston, MT 59643
Donald Maynard	165	Three Forks, MT 59752
Edmund E. Keller	330	2325 9th St. So. Great Falls, MT 59401
Samual Kirksey	715	Townsend, MT 59644
F. J. Kirscher	1010	Townsend, MT 59644
Francis C. Koehnke	350	Toston, MT 59643
Junior E. Lewis	90	Toston, MT 59643
Nan Mac Namara	363	N. 1622 Union Spokane, Wash. 99200

Frank McArthur	1045	Townsend, MT 59644
Walter T. Madill	1237	Townsend, MT 59644
Harold W. Marks	550	Townsend, MT 59644
Sewell Marks	100	Townsend, MT 59644
Don L. Miller	250	Townsend, MT 59644
Mildred Miller	138	Townsend, MT 59644
Mary E. Mitchell	250	Townsend, MT 59644
Mrs. R. F. Moudree	100	Townsend, MT 59644
James Plummer	165	Toston, MT 59643
Robert Gravelly	400	
Hubert Plymale	330	Townsend, MT 59644
John A. Plymale	75	Townsend, MT 59644
Maurice Hunsaker	600	Townsend, MT 59644
Wayne Plymale	330	Townsend, MT 59644
George D. Rauser	100	Toston, MT 59643
Walter F. Rauser	315	Toston, MT 59643
Roundgrove Ranch Co.	1500	Townsend, MT 59644
Mildred M. Neild	300	Townsend, MT 59644
Gordon Sanderson	212½	Toston, MT 59643
Gust L. Sanderson	160	Toston, MT 59643
Dennis H. Scoffield	792	Townsend, MT 59644
Donald Shearer	275	Townsend, MT 59644
Larry Shearer	75	Townsend, MT 59644
Edmund Schuman	10	Townsend, MT 59644
Jack Smith	234½	Toston, MT 59643
Kurt Spatzierath	700	Townsend, MT 59644
Wayne Toombs	1430	Townsend, MT 59644
Jed Stanfill	900	Toston, MT 59643
Tri-W-Ranch Co.	380	Townsend, MT 59644
Joseph Vercellin	30	Townsend, MT 59644
John J. Walter	90	Townsend, MT 59644
Mary J. Worline	750	Toston, MT 59643
Mrs. T. L. Watkin	400	Townsend, MT 59644
Gary Welch	390	Townsend, MT 59644
Total	29,017 3/4	

TELEPHONE QUESTIONNAIRE

*Project
*Contract Number
*Contract Starting Date
*Contract Length
*Contract Amount (M.I., Ac. Ft., Ac.)
*Current Charges: Principle
* O&M
* Special Assessment
*Contractor Name:
* Address:
* Phone:
Date Surveyed
Total Acres Irrigated Under Contract Non-Contract
Full Irrigation Acres Under Contract Non-Contract
Supplemental Irrigation Acres
Amount of Non-Contract Water & Source
Approximate Locations (Plot on Project Map
Principle Crops Raised With Contract Water (Fill Out Table):

Crop	Acres	Method of Irrigating (Flood, Sprinkler, Etc. If sprinkler, what kind)	Ac./Ft. of water used per acre	Full or Supple-mental	Yield (units/ acre)	Crop Value $/unit
1.						
2.						
5.						
4.						
5.						
6						

Was this a typical year? If not, what is? What is the trend, what is the history?

If sprinklers are used, when were they installed?
How have they affected acres irrigated, crops grown, water requirements, etc.

Would you buy more water if it were available?

Comments:

*Fill in before calling

Do you use water for purposes other than farm irrigation?
(Gardens, Stock Water, Etc.) How much for each?

What on-farm expenses have you incurred to make irrigation work on your farm?

Land levelling, number of acres, $,
Ditch construction, structures, etc., $, Describe

Sprinkler systems, $, Describe equipment

Special Machinery, $, Describe

Total Farm Operated Total Acres

Non-Irrig. Crops Raised, Rangeland, Recreational Enterprises, Etc.	Acres	Yield
1.		
2.		
3.		
4.		
5.		

Labor required to operate farm (man years) (family and non-family)

Are there any other benefits or good things about the project which we have not described?

Are there any other bad things, except cost? (Example-Seeped land, weed problems, pollution, etc.)

Comments:

The ideas and opinions expressed
in this report
are those of the author.
They do not necessarily reflect
the views of the
WICHE Commissioners or WICHE staff.

The Resources Development Internship Program
has been financed during 1972 by grants
from the
Economic Development Administration,
Jessie Smith Noyes Foundation,
National Endowment for the Humanities,
National Science Foundation
and by more than one hundred community
agencies throughout the West.

The preceeding intern report was completed by the following intern:

Name: G. V. V. Rao

Present Address: Department of Civil Engineering
Montana State University
Bozeman, MT 59715

Permanent Address:
c/o Mr. G. V. R. Krishna Rao
1/1 Kabir Road
Calcutta -26, India

Immediately prior to this internship, the intern was a student at:

College: Montana State University

Major Field: Civil Engineering

Year in School: Graduate

The preceeding intern report was read and approved by:

Name: Advisory Committee (Mr. Richard Bondy, Chairman)

Title: Project Engineer

Address: Water Resources Division
Montana Department of Natural Resources and Conservation
Helena, MT 59601

If you have further comments about this intern report, please write or phone:

Bob Hullinghorst, Director
Resources Development Internship Program
Western Interstate Commission for Higher Education
P.O. Drawer "P"
Boulder, Colorado 80302

Phone: 303--449-3333

THE RESOURCES DEVELOPMENT INTERNSHIP PROGRAM

The preceding report was completed by a WICHE intern during the summer of 1972. This intern's project was part of the Resources Development Internship Program administered by the Western Interstate Commission for Higher Education (WICHE).

The purpose of the internship program is to bring organizations involved in community and economic development, environmental problems and the humanities together with institutions of higher education and their students in the West for the benefit of all.

For these organizations, the intern program provides the problem-solving talents of student manpower while making the resources of universities and colleges more available. For institutions of higher education, the program provides relevant field education for their students while building their capacity for problem-solving.

WICHE is an organization in the West uniquely suited for sponsoring such a program. It is an interstate agency formed by the thirteen western states for the specific purpose of relating the resources of higher education to the needs of western citizens. WICHE has been concerned with a broad range of community needs in the West for some time, insofar as they bear directly on the well-being of western peoples and the future of higher education in the West. WICHE feels that the internship program is one method for meeting its obligations within the thirteen western states. In its efforts to achieve these objectives, WICHE appreciates having received the generous support and assistance of the Economic Development Administration, the Jessie Smith Noyes Foundation, the National Endowment for the Humanities, the National Science Foundation, and of innumerable local leaders and community organizations, including the agency that sponsored this intern project.

For further information, write Bob Hullinghorst, Director, Resources Development Internship Program, WICHE, Drawer "P", Boulder, Colorado, 80302, (303) 449-3333.

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